1,034,370

# PATENT SPECIFICATION

DRAWINGS ATTACHED

1034,370

Date of Application and filing Complete Specification March 8, 1963.

No. 11376/66.

(Divided out of No. 1034075).

Complete Specification Published June 29, 1966.



Index at acceptance: —B7 MP; B7 A(8D1, 8G); F2 R

Int. Cl.: —B 63 b//F 06 r

COMPLETE SPECIFICATION

## Method and means for Preventing Flow-Separation Alongside Ships' Hulls in Motion

## ERRATUM

SPECIFICATION No. 1,034,370

Page 1, Title, *after* "Method" *insert* "of"

THE PATENT OFFICE
*23rd December 1966*

ment of this layer is most easily understood by considering only the relative motion between the water and the ship. The layers of water making up the boundary layer flow in the direction of the stern of the ship (relative to the ship in forward motion) but those in close proximity to the hull are gradually slowed down owing to surface friction, in other words they are dragged along by the ship. This effect is aggravated at the after end of the ship by the adverse pressure gradient in the stream flow just outside the boundary layer, and in certain circumstances the boundary layer flow close to the hull may actually be reversed in direction. This results in the formation of vortices or eddies and the general breakdown in the stream flow. This may lead to a significant loss of energy which manifests itself in increased resistance, and may also have a serious effect

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adverse pressure gradient is such that backflow and separation would otherwise take place.

The present invention is also a ship having at the after end and on each side of its hull means for preventing flow-separation in the boundary layer when the ship is in forward motion, said means being adapted to boost or accelerate the flow in the boundary layer at the after-body of the ship and comprising fins on the hull exterior adapted on motion of the ship in a forward direction to produce vortices transverse to said flow and causing a mixing of the slow-moving water in the boundary layer with the faster-moving water outside the boundary layer at or near the point where the adverse pressure gradient is such that backflow and separation would otherwise take place.

Embodiments of the invention will now

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COMPLETE SPECIFICATION

## Method and means for Preventing Flow-Separation Alongside Ships' Hulls in Motion

I, HARRISON LACKENBY, a British subject, of 2 Warwick Square, Westminster, London, S.W.1, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of and means for preventing flow-separation (that is breakdown of streamline flow into eddies) alongside ships' hulls and hull appendages in motion. The term "hull" used hereinafter and in the claims is to be construed as including such appendages, e.g. propeller shaft supports such as brackets and bossings.

When a ship is travelling, a boundary layer or frictional belt of water (hereinafter and in the claims referred to as the "boundary layer") develops along the ship's length on each side of the ship The development of this layer is most easily understood by considering only the relative motion between the water and the ship. The layers of water making up the boundary layer flow in the direction of the stern of the ship (relative to the ship in forward motion) but those in close proximity to the hull are gradually slowed down owing to surface friction, in other words they are dragged along by the ship. This effect is aggravated at the after end of the ship by the adverse pressure gradient in the stream flow just outside the boundary layer, and in certain circumstances the boundary layer flow close to the hull may actually be reversed in direction. This results in the formation of vortices or eddies and the general breakdown in the stream flow. This may lead to a significant loss of energy which manifests itself in increased resistance, and may also have a serious effect on the performance of propellers and rudders. The adverse pressure gradient conductive to this disruption of the streamline flow of the boundary layer is more pronounced the steeper the flow lines or the fuller the form in the after body of the ship.

The object of the present invention is to obviate or mitigate the disadvantage described in the immediately preceding paragraph.

The present invention is a method of preventing flow-separation alongside the hull of a ship in forward motion, comprising boosting or accelerating the flow in the boundary layer at the after-body of the ship on each side of the ship, by forming in said boundary layer vortices transverse to said flow and causing a mixing of said flow with that of the faster-moving water outside the boundary layer at or near the point where the adverse pressure gradient is such that backflow and separation would otherwise take place.

The present invention is also a ship having at the after end and on each side of its hull means for preventing flow-separation in the boundary layer when the ship is in forward motion, said means being adapted to boost or accelerate the flow in the boundary layer at the after-body of the ship and comprising fins on the hull exterior adapted on motion of the ship in a forward direction to produce vortices transverse to said flow and causing a mixing of the slow-moving water in the boundary layer with the faster-moving water outside the boundary layer at or near the point where the adverse pressure gradient is such that backflow and separation would otherwise take place.

Embodiments of the invention will now

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be described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a perspective view from below and to one side of the after end of a single screw merchant ship form illustrating the general breakdown of flow in the boundary layer at the after end of a ship's hull when in motion;

Figs. 2 to 5 are perspective views of a portion of a ship's hull at the after end and at one side of the ship, illustrating different forms of vortex-producing devices for use in boosting or accelerating the flow in the boundary layer.

Throughout the drawings, like parts are denoted by like reference numerals.

Referring firstly to Fig. 1 of the drawings, the reference numeral 20 broadly denotes the after end of a ship's hull, 21 denotes a screw-propeller and 22 denotes a rudder. The arrows E denote the general breakdown of the stream flow alongside the hull which occurs when the boundary layer, the normal flow of which is denoted by the arrows D, separates from the hull 20 due to reversal of the flow. Only one side of the ship is shown or referred to in Fig. 1 and the other Figs. in the drawings, but it will be understood that similar conditions apply at each side of a ship.

Figs. 2 to 5 of the drawings illustrate constructions in which vortex-producing fins are provided one above the other on the surface of the hull 20 at the after end and at each side of the ship to intercept the flow D in the boundary layer and generate vortices transverse to said flow as denoted by the arrows F at the after ends of the fins when the ship moves in a forward direction. In these constructions, the fins cause a mixing of the slow-moving water in the boundary layer with the higher velocity water from the flow outside the boundary layer and thus increase the velocity of flow in the boundary layer.

Referring firstly to Fig. 2, the fins 35 are shaped to present aerofoil surfaces to the flow in the boundary layer D. It is preferred that the fins 35 be inclined to the flow with successive fins inclined in opposite directions and alternate fins at the same inclination, as shown, in order to minimise their effect on the mean stream flow over the hull 20.

In Fig. 3 the fins 36 are flat plates normal to the surface of the hull and inclined to the flow in the boundary layer D in the same way as the fins 35 in Fig. 2.

In Fig. 4 the fins 37 are wedge-shaped, and each is disposed with the taper in the direction of flow and with the outside surface 38 providing an outwardly-inclining ramp to the flow In this construction the fins are axially disposed relative to the flow D in the boundary layer and each generates oppositely-whirling vortices as indicated by the arrows F.

In Fig. 5, the construction is similar to Fig. 4 but the wedges 37 of the latter are replaced by plates 39 in the shape of arrow heads disposed with the taper in the direction of flow and supported from the hull by wedge-shaped plates 40 to provide an outwardly-inclining ramp to the flow.

In the case of a single screw ship with a propeller placed directly behind the hull, the propeller itself will accelerate the boundary layer flow at the extreme after end to a certain extent by suction.

It may be possible by application of the present invention to increase the fullness of stern lines of ships beyond present limits and this is desirable especially in cargo ships and notably in tankers.

Manifestly the present invention could be applied both in the construction of new ships and in the modification of existing ships.

WHAT I CLAIM IS:—

1. A method of preventing flow-separation alongside the hull of a ship in forward motion, comprising boosting or accelerating the flow in the boundary layer at the after-body of the ship on each side of the ship by forming therein vortices transverse to said flow and causing a mixing of said flow with that of the faster-moving water outside the boundary layer at or near the point where the adverse pressure gradient is such that backflow and separation would otherwise take place.

2. A ship having at the after end and on each side of its hull means for preventing flow-separation in the boundary layer when the ship is in forward motion, said means being adapted to boost or accelerate the flow in the boundary layer at the after-body of the ship and comprising fins on the hull exterior adapted on motion of the ship in a forward direction to produce vortices transverse to said flow and causing a mixing of the slow-moving water in the boundary layer with the faster-moving water outside the boundary layer at or near the point where the adverse pressure gradient is such that backflow and separation would otherwise take place.

3. A ship according to claim 2, wherein said fins are shaped to present aerofoil surfaces to the flow in the boundary layer.

4. A ship according to claim 2, wherein said fins are flat plates normal to the surface of the hull.

5. A ship according to claim 3 or 4, wherein said fins are inclined to the flow in the boundary layer with successive fins inclined in opposite directions and alternate fins at the same inclination.

6. A ship according to claim 2, wherein said fins provide an outwardly-inclining ramp of converging width in the direction of the flow.

7. A ship having at the after end and on each side of its hull means for preventing flow-separation in the boundary layer when the ship is in motion, substantially as hereinbefore described with reference to any of Figs. 2 to 5 of the accompanying drawings.

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5 Park Gardens, Glasgow, C.3.

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Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

FIG1

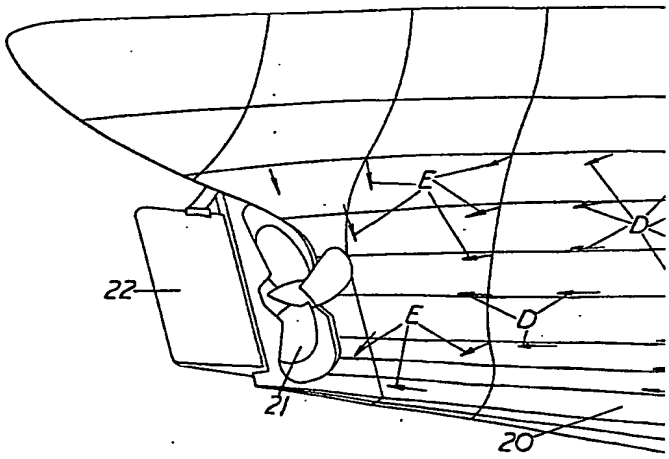
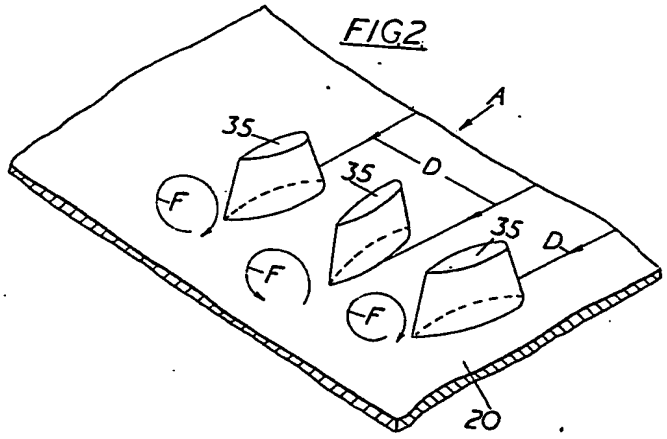



FIG2



1034370 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG1

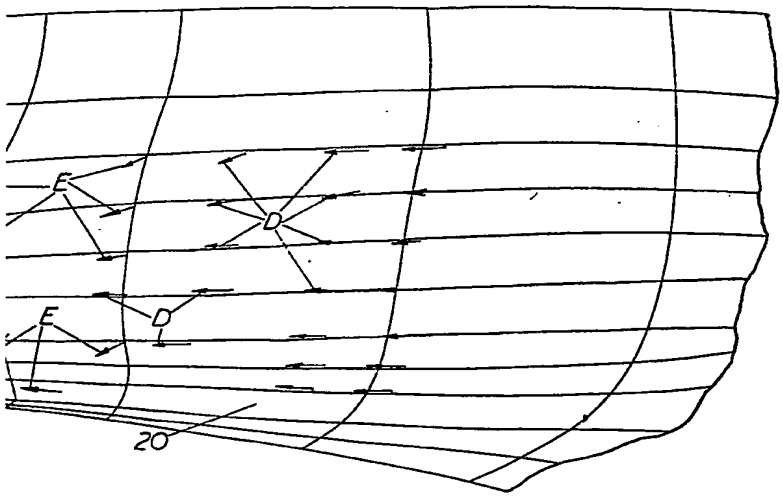



FIG3

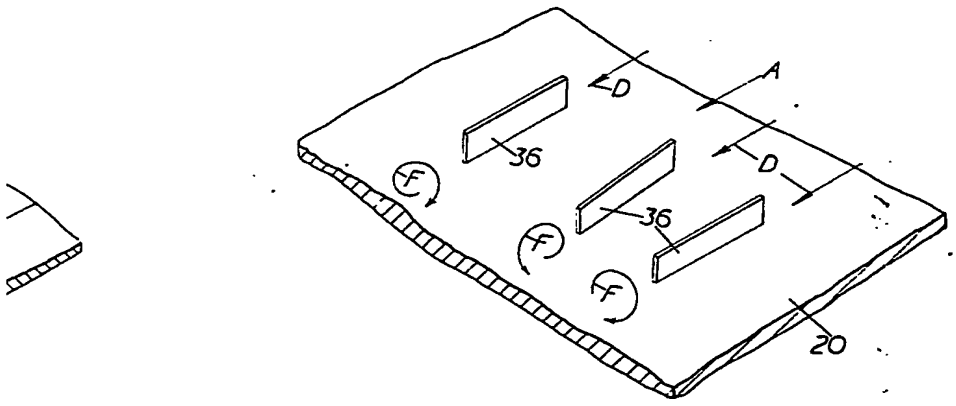


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FIG1

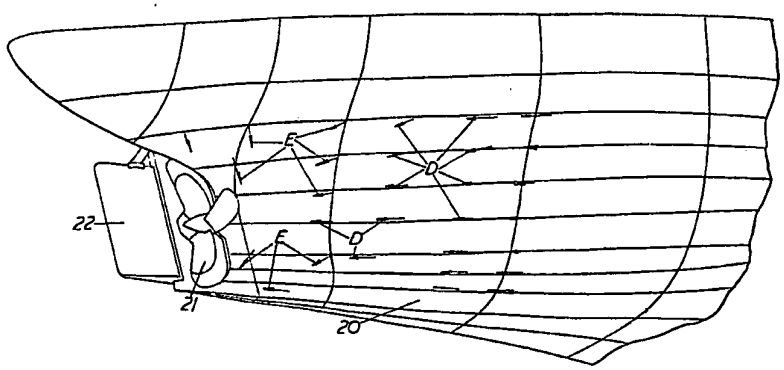



FIG2

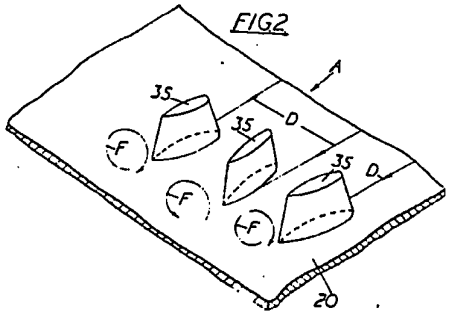
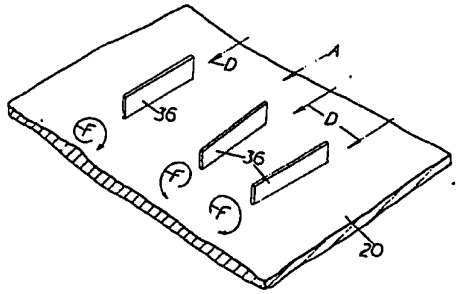



FIG3



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Sheet 2

FIG4

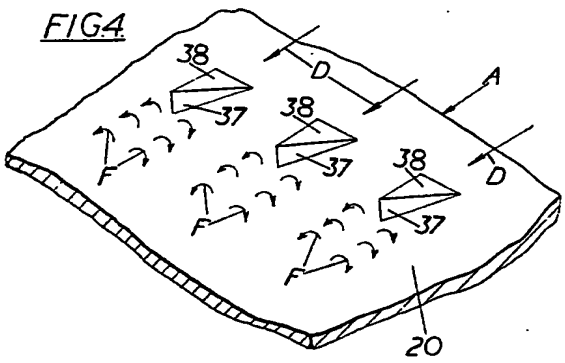


FIG5